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Chapter 5. Facilities Maintenance Program Execution

5.1 Introduction

This chapter describes the work functions required to execute a maintenance program. These functions begin with work generation and proceed through work reception and tracking, work-order preparation, and work execution. The various steps required to perform these functions are described. They are not meant to present an organizational structure but to include suggested functional work areas required to implement a maintenance program. Additionally, in this chapter, the term "shops" is used to refer to the facilities maintenance workforce, including both civil service employees and, in most cases in NASA, support services contract employees.

5.2 Key Processes Overview

5.2.1 The AWP is the basis for a year's initial work planning. (See Chapter 4, Annual Work Plan.) This plan is augmented with customer requests, identification of new requirements, equipment breakdowns, and other emergent requirements. It is important to document the specific maintenance work items in the AWP and all requests for maintenance, repair, and service work. Work requested is received, processed, and, if approved, converted into a work order as shown in Figure 5-1. Work disapproved is returned to the customer with an explanation or request for clarification. Work that is valid but cannot be accomplished within the immediate resources is then deferred. If it is still valid at the end of the year and cannot be funded, it will be considered for inclusion in next year's AWP or the DM. All documents should be filed and retained in accordance with guidance provided in NPR 1441.1, NASA Records Retention Schedules.

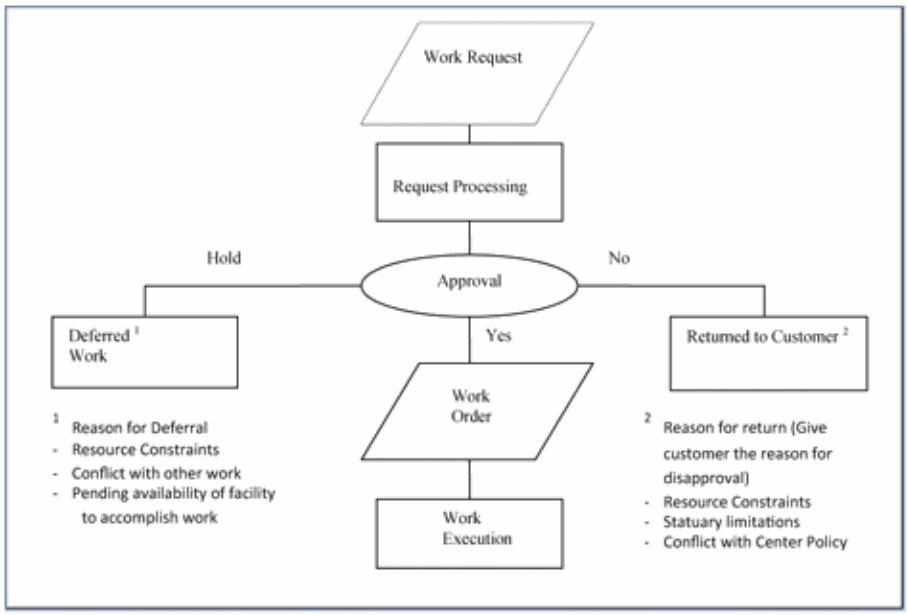

Figure 5-1 Work Request Processing

5.2.2 Centers should have work control systems that receive, classify, identify, estimate, approve, schedule, track, account for, analyze, and report all work throughout the facilities maintenance process, from inception to completion as shown in Figure 5-2. In NASA Centers, the control system utilizes CMMS. It comprises the tools, techniques, checks, management controls, and documentation needed for effectively managing the workflow with an automated system. (See Chapter 6, Facilities Maintenance Management Automation.)

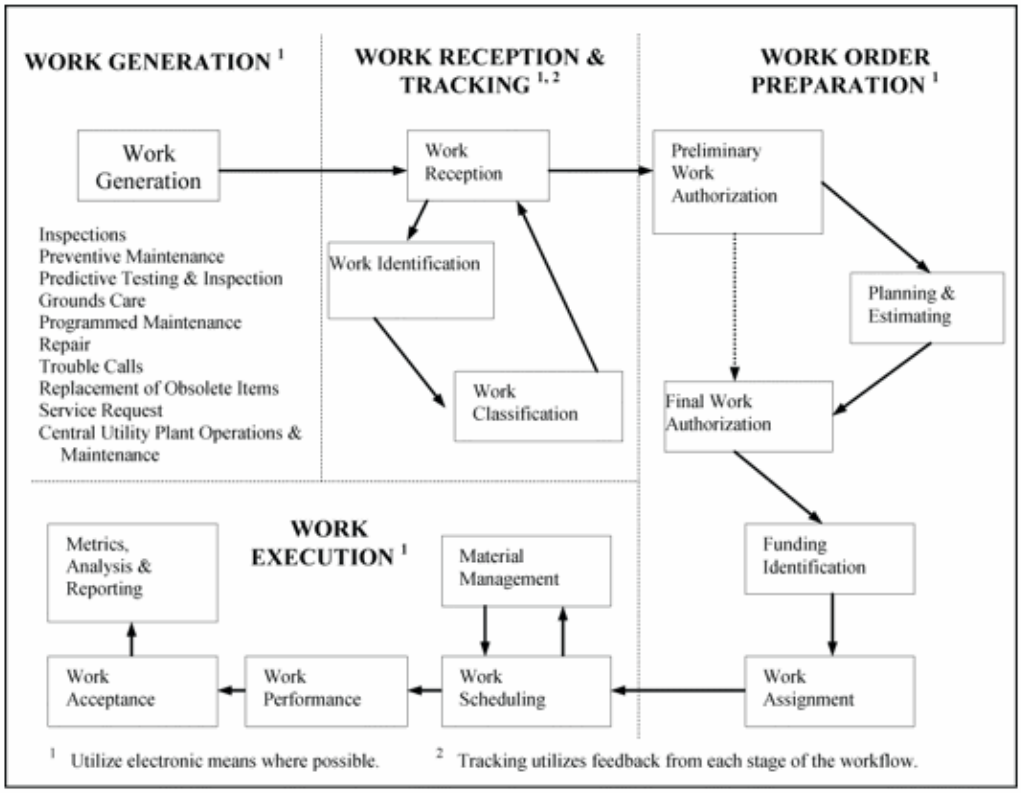

Figure 5-2 Stages in Work Generation, Control, and Performance

5.3 Work Generation

5.3.1 Work generation is the process of determining the maintenance workload in the facilities maintenance management system. A part of work generation is documenting the workload in the CMMS. Facilities maintenance work comprises recurring and nonrecurring maintenance work. Recurring work includes PM, PT&I, grounds care, central utility plant O&M, and the facilities condition assessment program. The recurring maintenance programs,

customer needs, and facilities and equipment failures generate nonrecurring maintenance work in most cases.

5.3.2 Facilities Maintenance Work. A significant portion of the facilities maintenance workload results from ownership and inventory. This is largely recurring/repetitive work that can be predicted based on knowledge of the maintainable facilities and collateral equipment and utilizing NASA's RCM program. (See Chapter 7, Reliability Centered Maintenance.) This work forms the basic elements of the AWP. Examples of this work include PM, PT&I, PGM, and recurring work, such as grass cutting and relamping. The scope and extent of these kinds of work are typically defined when a facility is acquired. (See Chapter 8, Reliability Centered Building and Equipment Acceptance.)

5.3.3 Facilities Condition Assessment Program. In effective facilities maintenance programs, most of the facilities maintenance work other than PM and operator maintenance is generated from the facility condition assessment program and predictive testing conducted by or under the auspices of the facilities maintenance organization. Condition assessments are evaluations of Center facilities, including collateral equipment, utilizing continuous inspections, PT&I, and CMMS data. The inspections include those occurring during day-to-day maintenance operations; operator, user, and facility manager inspections; and separate supplemental inspections. The Center's CMMS, TC, and repair data are evaluated as part of the condition assessment to determine trends that can be used in evaluating the condition of a facility and its maintenance program. The facility condition assessments are used to validate and update the Center's AWP, DM , ROI, and Five-Year Plan. Chapter 10, Facilities Maintenance Standards and Actions, describes the condition assessment program and its inspections.

5.3.4 Trouble Calls

5.3.4.1 Normally, TCs are reported by telephone to the work reception desk. Operating the work reception desk is one of the functions performed by the work control center (see paragraph 5.4, Work Control Center). It is recognized that at some Centers, the term "trouble call" means anything that is wrong and needs correcting. Therefore TCs coming to a work control center must be evaluated. Only facilities maintenance and repair items should be included in the facilities program. Other items such as a coffee spill on a carpet, weeds that need to be removed, a floor needing to be cleaned, supplies needed in a restroom, ants or bugs in a desk needing pest control, must be assigned or passed along to the appropriate program. TCs must be properly coded to maintain records for facilities evaluations and budgets.

5.3.4.2 Although TCs can be placed by anyone, the recommended practice is to designate one individual in each major building or organization as the point of contact for placing TCs. This minimizes duplication of effort and simplifies work tracking. Emergency calls are accepted from anyone. In recognition of the limited scope of work covered by a TC, it is normally not estimated or scheduled, but it is tracked for execution. Appendix D, Figure D-1, is a sample format with data element definitions for a TC ticket that can be used to document and track TCs. This format should be automated to permit entering the request in the CMMS at a computer terminal and automatically issuing the work order to the shops. All documents and records should be filed and retained in accordance with guidance provided in NPR 1441.1, NASA Records Retention Schedules.

5.3.5 Service Requests. A service request is new work requested by a customer. It may be either a small job that does not require planning and estimating or a large job that requires planning, estimating, and scheduling. The request may be submitted on a Request for Facilities Maintenance Services form as shown in Appendix D, Figure D-2 or another appropriate Center form. The form should be automated for submitting, recording, and processing the request. Normally, service requests are customer funded. All documents and records should be filed and retained in accordance with guidance provided in NPR 1441.1, NASA Records Retention Schedules.

5.3.6 Other Requests. Other requests for facilities maintenance work include work not identified as part of the facilities maintenance inspection program. Examples are maintenance deficiencies found during a fire safety inspection or a request for repairs for a problem that has occurred since the last facilities maintenance inspection. These requests should be tracked separately to provide status and execution feedback to the customer and to monitor the effectiveness of the facilities maintenance inspection program.

5.4 Work Control Center

5.4.1 The Work Control Center (WCC) is the nerve center for facilities maintenance management. It is the preferred central location for managing the execution of facilities maintenance work. The following are WCC functions:

a. Receiving and logging work generated from all sources.

b. Assigning a unique identifier or designator to each work item.

c. Assigning initial classifications to the work.

d. Tracking the work as it progresses through the facilities maintenance system.

e. Maintaining records on requested work, inspections, jobs in progress, and completed work.

5.4.2 The work control function may be assigned to any organizational element in the facilities maintenance organization; however, it is suggested that it be assigned directly under the facilities maintenance manager,

independent of the shops or planning and estimating functions. It may be staffed and operated by civil service or contract employees. However, if operated by a support services contractor, care must be taken to ensure that the contract specifies detailed performance requirements and that an effective quality-assurance program is maintained. In addition, if the contractor is tasked with operating and maintaining the CMMS, the contract must provide for direct Government access to the CMMS facilities maintenance management database and report generators. This is required for purposes of queries on work status, analysis of work statistics, preparation of facilities maintenance reports, and facilities maintenance management surveillance. Providing CMMS terminals at designated Government offices will enable the Government to accomplish this.

5.5 Work Reception and Tracking

5.5.1 The major work reception functions, in addition to ensuring that requested work is defined as clearly as circumstances permit, are as follows:

5.5.2 Work Reception. Work reception accepts and records work requirements resulting from the work-generation process. Emergencies are evaluated when they are received in work control and the appropriate action is taken to ensure the emergency situation is stabilized (see paragraph 5.3.4, Trouble Calls). Work reception initiates the administrative control of the work-management data as the work progresses through the maintenance-management system.

5.5.3 Work Identification. Each item of work is given a unique identifier or designator, much like a serial number. This identifier permits tracking the work item through its life cycle of planning, approval as a work order, execution, and historical documentation. The identification scheme should meet the Center's needs. The use of automation simplifies the identification process. For example, CMMS-generated identifiers can be purely sequential numbers because the computer can track all of the attributes such as fiscal year, work classification, and fund source associated with each identification number. The work identifier should not be changed once it is assigned, even if the work is combined with another work item. The computer can provide the cross-reference to the combined identifier.

5.5.4 Work Classification

5.5.4.1 Work classification provides the ability to subject work to the proper levels of review and control and to perform management analyses of the workload. The suggested categories for work classification are discussed below. These categories extend beyond the minimum required for financial accounting and budgeting and provide additional detail for managing the facilities maintenance organization. They are important for managing the workload and understanding where resources are expended.

5.5.4.2 The use of automated systems permits ready accumulation and analysis of the data. Centers may wish to add additional classifications for local use. The following are some methods of classifying work:

a. Funds type.

b. Approval level.

c. Work elements.

d. Special interest.

e. Size.

f. Method of accomplishment.

5.5.4.3 Each method is discussed below. Note that the work classification within any of these categories may be changed during the course of the work planning. Thus, the use of an unchanging, unique identification system, such as described in paragraph 5.5.3, Work Identification, is particularly important.

a. Funds Type. Funds type describes whether the work is reimbursable or nonreimbursable. If the work is reimbursable, the fund citation normally identifies the customer; if it is nonreimbursable, the funds citation normally identifies the appropriation and project or program. Funds type is not the same as funds source because funds source does not identify the specific reimbursable customer, program, or project.

b. Approval Level. Approval level identifies who has the authority to approve the work. Specific approval levels are determined by Center policy and, when documented, become a local "standard." Common practice is to delegate work-approval authority to permit routine and recurring work approval at the lowest responsible level in the facilities maintenance organization. Some work, such as TCs of an emergency or routine nature, may be preapproved within specific guidelines. The designation of individuals authorized to approve work based on a hierarchy of cost, urgency, or other management considerations should be documented in the WCC.

c. Work Elements. Work element identifies which of the following standard work elements (see paragraph 1.5, Facilities Maintenance Definitions) applies:

1. PM.

2. PT&I.

3. Grounds Care.

4. PGM.

5. Repair.

6. TC.

7. ROI.

8. Service Request.

9. Central Utility Plant O&M.

The above work element categorization is useful in analyzing the relationships described in paragraph 3.11.4, Work Element Relationships.

d. Special Interest. This classification identifies and permits the accumulation of statistics on the work performed in support of specific or special interest programs or initiatives, or work not otherwise accounted for by special funding programs. Examples include the following:

1. Energy Conservation.

2. Safety.

3. Environmental Compliance.

4. Handicapped Access.

5. Community Relations.

e. Size. Work size, grouped in dollar or level-of-effort ranges, indicates the amount of management effort required. This classification is useful in determining the type of funds used, the approval level, and the method of accomplishment.

f. Method of Accomplishment. The method of accomplishment identifies whether the work will be accomplished by civil service employees, by established support service contractors (if the work is determined to be within the contract scope), or under a separate, new contract.

5.5.5 Work-Tracking System

5.5.5.1 A work-tracking system enables work tracking from the time the work enters the facilities maintenance system until it is either disapproved or completed. A Center's CMMS is the tool to be utilized for work tracking and status reporting.

5.5.5.2 Work status refers to the state of work progress in the facilities maintenance system as it proceeds from generation to completion. It includes the identification of actions completed, actions pending, responsible parties, and milestone dates. Work status is a key element in maintaining good customer relations by making it possible to provide responsive feedback to the customer. The CMMS should provide the means for documenting and reviewing work status. A suggested way of accomplishing this is assigning status codes or milestone data to each item of work. Personnel with CMMS access can then examine the status information and use it when preparing reports.

5.5.5.3 At a minimum, the CMMS should contain the estimated or actual start and completion dates and identify the responsible party for each of the following milestones in the facilities maintenance process:

a. Work Reception (including classification and identification phases).

b. Planning and Estimating.

c. Final Authorization.

d. Scheduling.

e. Material Management.

f. Work Performance.

g. Final Inspection.

5.5.5.4 Not all milestones are applicable to all work. For example, for TCs, only status information related to work reception and work performance would be tracked. Data for final authorization, scheduling, material, work performance, and final inspection would not be recorded for requests for cost estimates only. The shop load plan

and master schedule typically contain material and work performance status information for scheduled work.

5.6 Work-Order Preparation

5.6.1 The work order (Appendix D, Figure D-3) is the document directing facilities maintenance work execution once the requested work has been approved. Normally, planners and estimators (P&E) prepare work orders. An exception is the TC ticket discussed in paragraph 5.6.2 below. The work order includes an estimate of the resources required to perform the job (work hours by craft, materials, equipment, tools, and specialized support); the steps or tasks required performing the job; and documentation of coordination and outages required. It should also include safety requirements, job priority, job accounting information, and any other information required by management and the shops to schedule, perform, and evaluate the work. Safety requirements should include, but not be limited to, appropriate safety items such as confined space entry, lockout/tag out, oxygen depletion, chemical or explosive handling, fall protection, safety training and certification requirements, and any other specific safety requirements associated with the task to be accomplished under the work order (refer to NPR 8715.3 NASA General Safety Program Requirements, paragraph 8.3). The work-order form should be automated (included in the CMMS).

5.6.2 For small jobs, typically less than 20 work hours, the cost of detailed planning and estimating and scheduling may exceed the benefit. However, the craft supervisor responsible for the TC must review the TC task and specify safety requirements such as those in paragraph 5.6.1 above. In these cases, use of a TC ticket format (Appendix D, Figure D-1) is suggested. This ticket should be automated (included in the CMMS).

5.6.3 Work Review, Screening, and Authorization. Work review, screening, and authorization is typically a two-step process. Requests for work receive an initial screening prior to job planning and estimating. The second step provides final approval and release of the planned and estimated work order for scheduling. In the case of TCs and work on small jobs, this may be accomplished in one step, within the decision authority of the work reception desk, bypassing planning and estimating. In Figure 5-2, the dotted arrow connecting the preliminary and final work authorization blocks symbolizes this.

5.6.3.1 Preliminary Work Authorization. Authorization is the process by which facilities maintenance work is approved for performance. This may be a phased process in which preliminary approval is obtained prior to detailed planning and estimating as shown in Figure 5-2. The preliminary screening determines if requested work should be accepted for continued processing, rejected, returned to the customer for additional information, or given preliminary approval for detailed planning and estimating. For work of limited scope, it may also serve as the final authorization if funds are available.

5.6.3.2 Final Authorization

a. Once the work order is planned and estimated, it is forwarded for final authorization. The review process checks the work order to ensure that it is responsive; complies with applicable safety, health, environmental, and security standards; is within the scope of the AWP; and is within funding and approval levels. This review normally takes place in the facilities maintenance organization. However, on complex or critical jobs, the customer should review the work order to check its technical adequacy.

b. When reviews are completed and funds are available, the work order is authorized for execution by the appropriate approving official (see paragraph 5.5.4.3b., Approval Level).

5.6.4 Planning and Estimating. Center work control systems should contain a planning and estimating function. This function provides the detailed definition of maintenance tasks or steps to be taken, the resources required (material, equipment, tools, and labor), and special considerations such as safety outages and coordination. It supports budgeting, resource allocation, and work performance decision processes and provides a benchmark for work performance evaluation. A part of the planning and estimating function is the process of developing the work order documenting the detailed work tasks and preparing an estimate of the resources required. The work order includes statements of the job steps or phases for each craft, a list of the required materials, and the identification of special tools or equipment needed. It includes an estimate of the time required for each phase, copies of sketches or drawings, the identification of safety requirements and required outages, and allowances for staging, travel, site cleanup, and other job-related actions. For contracted work, the work order is replaced by the Statement of Work (SOW) that includes sketches, a job specification or performance work statement, and a cost estimate appropriate to the contract form used. Planning and estimating provide the basis for the following:

a. Deciding to approve, disapprove, or defer work.

b. Developing costs and budget estimates.

c. Determining the method of accomplishment.

d. Preparing the shop load plan, the master schedule, and the shop schedule.

e. Evaluating shop or contractor performance and efficiency.

f. Establishing contract costs.

5.6.4.1 Facilities Maintenance Standards. Facilities maintenance standards are discussed in Chapter 10, Facilities Maintenance Standards and Actions. They establish the level and condition in which facilities and equipment are maintained. Standards serve as guides in determining the facilities maintenance work. P&Es determine the job tasks by comparing existing conditions with the prescribed maintenance standards and then selecting job tasks (maintenance actions) that bring the facility up to those standards.

5.6.4.2 Performance Standards. Planning and estimating is a skill requiring substantial knowledge of the crafts and methods involved. However, it is unlikely that one person is expert in all aspects of a craft. There are a number of estimating guides and standards available to assist P&Es in preparing work orders and estimates (see list in Appendix C). Equipment manufacturers also produce standards. All standards must be applied with care, taking into consideration local conditions, area cost factors, and experience. However, use of cost-estimating guides and standards is encouraged as a means of improving the quality, reliability, and consistency of estimates.

5.6.4.3 Work Planning. Work planning consists of identifying specific tasks to be performed, phasing those tasks, identifying the skills and crafts required for the tasks, and specifying the material and equipment for the tasks. It includes identifying specific health and safety requirements, coordination, outages, equipment availability, and other constraining parameters. As with the other P&E functions, established standards also can provide assistance in work planning. Table 5-1 provides examples of selected facilities maintenance tasks, with the cycle or interval between performances of the task suggested for use by NASA Centers. The intervals listed assume average conditions. Centers may adjust these to suit local use and environmental conditions.

5.6.4.4 Cost Estimating. Cost estimates are developed by multiplying unit labor, equipment, and material costs by job task quantities, and adding the appropriate burden rates for overhead and indirect costs. The exact type of the cost estimate depends on its intended use. For example, overhead costs, profit, bond expense, and taxes required for contract work are omitted for in-house work. Cost estimates can be classified based on the amount of detail considered in their preparation as scoping estimates or final estimates. Cost estimates normally are prepared using industry-accepted standards (see R.S. Means Company, Inc., Appendix C) or historical data. These factors are discussed in the following paragraphs:

Table 5-1 Selected Facilities Maintenance Cycles

Task Examples	Suggested Cycle (Years)
Painting	
Interior	
Office areas, corridors, restrooms	5
Industrial areas, high bays, hangars, machine shops, clean rooms	15
Exterior	
Personnel doors and jambs, overhead doors	4
Steel siding, piping, exhausters, air dryers	8
Wind tunnel shells, vacuum spheres, high-pressure gas bottles	10
Pavement	
Asphalt	
Sealcoat, slurry coat	6-8
Overlay (1-1/2 in.)	
Roads	15
Parking lots	20

Restriping	
Roads	2-4
Parking lots	5-8
Concrete	
Joint sealant, replace 10%/year	10
Crack repairs, average linear feet/year	2
Sidewalks	
Replace broken curbs, 10% of total/year	10
Replace broken/deteriorated sidewalks, 10% of total ft^2/year	10
Roofing	
Floodcoat built-up roofs, 10% of total/year	10
Refasten flashing, cut and patch bubbles, clean/repair gutters/downspouts, 20%/year	5

Note: These cycles should be adjusted locally based on historical experience and environmental conditions.

a. Scoping Estimate. This estimate is based on broad unit cost guidelines; it does not involve a detailed job plan or design. It is not appropriate as the basis for job performance evaluation or contract negotiations. The scoping estimate is used in situations that do not call for details and high accuracy. Examples include estimates for developing budgets, estimates to aid in screening work packages to be included in the DM, or preliminary estimates for initial decisionmaking on a request for work.

b. Final Estimate. This estimate is based on detailed job plans (as found in a facilities maintenance work order) or final contract plans and specifications. It is more reliable than a scoping estimate. Job performance evaluations, contract negotiations, or other exacting uses should be based on a final estimate because it reflects a detailed knowledge of the individual facilities maintenance actions and the resources required. A final estimate can substitute for a scoping estimate, but it is more costly to produce.

c. Historical Estimate. The historical estimate uses prior performance of the maintenance tasks involved as its basis. It can have excellent validity, provided the new job tasks and methods are comparable to the historical database used in preparing the estimate. There is minimal cost in developing a historical estimate. However, care must be taken to ensure that the historical data applies to the current job scope. Periodic validation of historically based estimates against estimating standards is necessary to ensure that they are in line with accepted standards. This type of estimate is especially valuable for repetitive or recurring tasks such as PM.

5.6.4.5 Funding Identification. Funding identification covers the identification, allocation, and authorization of the proper funds. It includes Center operating funds, customer reimbursable funds, and special funds.

5.6.4.6 Each work order includes a funding citation and accounting data identifying which funds to charge for the work. In some cases, funds are customer furnished (reimbursable). In others, funds are specifically budgeted by the Center for facilities maintenance. When work is customer funded, appropriate funding documents should be furnished in a timely manner to ensure that work is not delayed unnecessarily. A correct funding citation ensures that the proper account is charged and provides valid accounting data for management reporting.

5.6.4.7 Customer-funded work could be time sensitive to support a given mission. As a result, a suspense system should be in place to track work requests waiting for funding so as to preclude unnecessary administrative delays and customer dissatisfaction.

5.6.5 Priority Systems

5.6.5.1 The work-order system must make provision for differing work priorities. This allows high-priority work to be done first while managing all work to ensure its accomplishment in accordance with Center needs. Figure 5-3 shows a sample priority system. The priority is normally determined as part of the work-review process. It guides material procurement, scheduling, and work execution.

5.6.5.2 Priorities require periodic review to ensure that they conform to organization and mission needs. When using a CMMS, a special designator can be added to the database to help track high-visibility projects. An example would be safety items from an inspection. While these items could fall in several of the priorities shown in Figure 5-3, they may need to be tracked as a group for accomplishment. A special local code designation will ensure that they can be readily highlighted for management purposes.

General Maintenance Work Priority System	
Priority/Description	**Narrative**
1. Emergency	Safety of life or property threatened; immediate mission impact; loss of utilities. Begin immediately; divert resources as necessary; overtime may be authorized.
2. Urgent	Maintenance or repair work required for continued facility operation; should be completed to ensure continuous operation of the facility and to restore healthful environment. Not a life-threatening emergency. Respond upon completion of current work but within a specified period of time (specified by local Center, such as same day or within 4 hours).
3. Priority	Work that is to support the mission on a priority basis or to meet project deadlines. Complete in order of receipt with mission work taking priority.
4. Routine	The facilities maintenance work can be scheduled routinely within the capability of the facilities maintenance organization. Facilities work is subject to availability of resources and may be consolidated by facility or zone or as directed to obtain efficiency of operation.
5. Discretionary	Work that is desired but not essential to protect, preserve, or restore facilities and equipment; typically, new work that is not tied to a specific mission milestone.
6. Deferred	Work that may be safely, operationally, and economically postponed. The work should be done, but cannot be scheduled because of higher priority work, funds shortage, work site access, or conditions outside the control of the maintenance organization. The work may be reclassified if conditions permit or included in the DM.

Figure 5-3 Sample Priority System

5.7 Work Execution

5.7.1 After planning and approval comes work execution, which includes the following:

a. Obtaining material, tools, and equipment.

b. Scheduling the work.

c. Performing the work.

d. Monitoring work accomplishment.

e. Final inspection.

f. Reporting work completion.

5.7.2 Material Management

5.7.2.1 Material management includes ordering, stocking, storing, staging, issuing, and receiving material for use on work orders. Material management can be performed by an element of the facilities maintenance organization, a central supply department not a part of the facilities maintenance organization, or a combination of these. (Tool management may be assigned to the same organization that has the material management responsibility.) Working from material requirements lists prepared by P&Es as part of the work order, the material manager is responsible for obtaining the material and advising the work schedulers when the material is available for job accomplishment. In the case of PM, other recurring and standing work, and TCs, material managers should have available, or provide ready access to, frequently used parts and supplies. This material may be preexpended shelf stock, or it may be available from vendors by use of a Government credit card or from vendors who are accessible under quick procurement instruments such as blanket purchase agreements.

5.7.2.2 The range and depth of material stocked should be based on historical demand, standby items (spares for critical systems), and projected requirements for future work. Inventory high and low limits should be established based on use rates, economic reorder quantities, and delivery times to minimize investment in inventory. Where advantageous, alternate material management strategies can be used such as "just-in-time" parts delivery. The benefits available are the reduction in inventory costs associated with storage, management, pilferage, and cannibalization. Many automated maintenance management systems include support for computerized material management functions. Bar coding is used extensively in material management to speed data entry and reduce data-entry errors.

5.7.3 Scheduling. Scheduling work orders is necessary to ensure a balanced flow of work to the shops in accordance with priorities, external factors (such as weather), and operational considerations. It facilitates optimum use of resources and provides information to optimize the distribution of shop staffing by craft. The AWP identifies resource levels for each facilities maintenance program work element. It also identifies major work items to a fiscal year. However, most facilities maintenance work orders, including Service Requests, will not have individual visibility in the AWP. They are included as part of a level-of-effort resource allocation for the fiscal year. Within the fiscal year, work scheduling may be done at three levels: the shop load plan, the master schedule, and the shop schedule. The relationship of these plans is depicted in Figure 5-4.

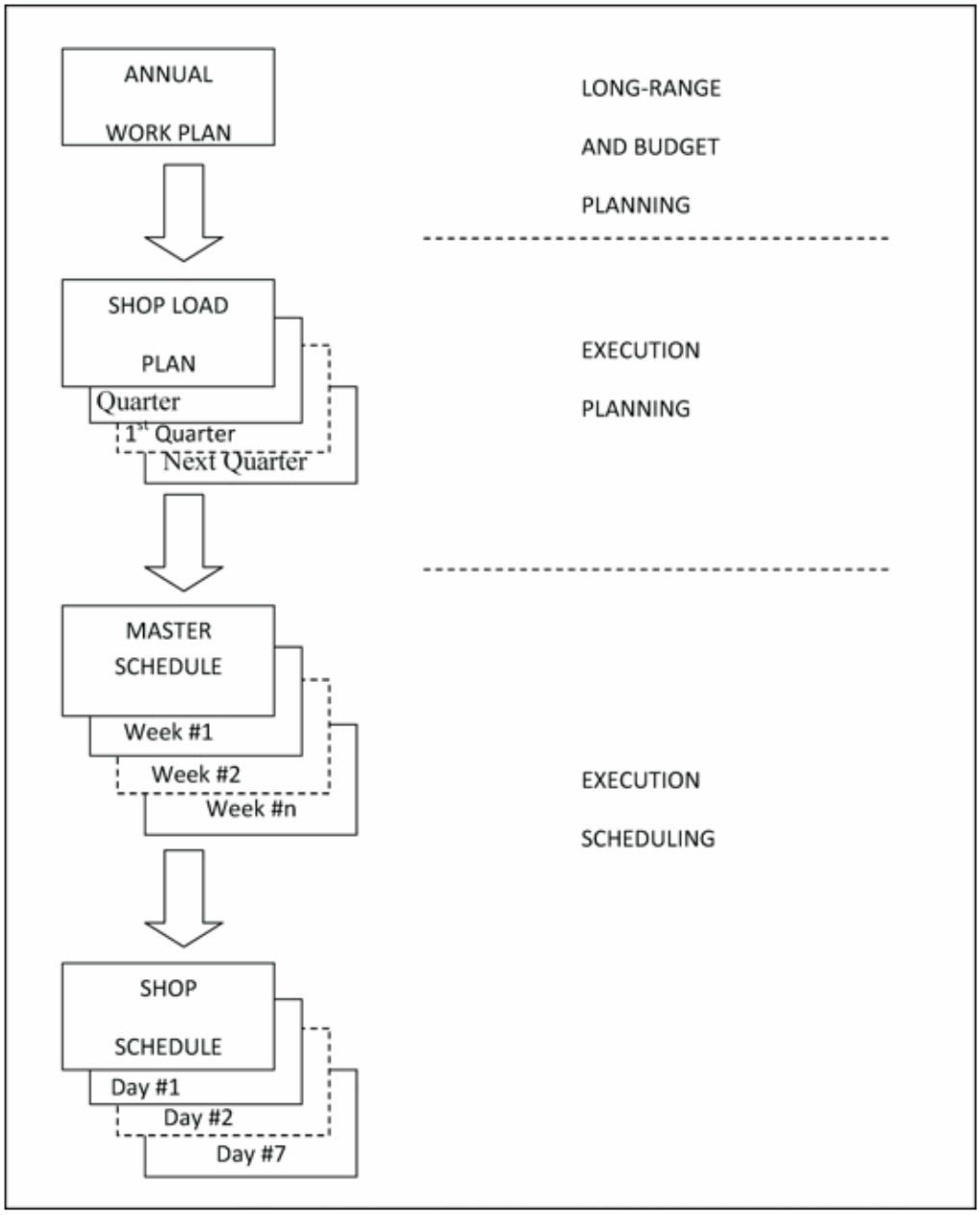

Figure 5-4 Work Scheduling Relationships

5.7.3.1 Shop Load Plan

a. The shop load plan is usually maintained by the organizational element responsible for the work control function. It schedules work to the shops on a periodic basis, typically quarterly, and looks several quarters into the future. This plan reflects the backlog of estimated work as defined in the AWP for the current and following year. Work may be added or shifted among the schedule periods as new work is identified or work priorities change, although the plan for the next schedule period should be fairly stable. A Center may find it convenient to divide the next quarter's shop load plan into a short-term (30-day) plan and a midterm (following 60 days) plan for closer scheduling.

b. The shop load plan considers available production resources (i.e., work hours by craft, tools and special equipment, and contract limitations), availability of items to be maintained such as times for shutdowns and external factors such as weather. It considers work already scheduled or in progress; allowances for recurring work such as PM, PT&I, and TCs; and long-lead-time material requirements. With these factors in mind, the planner loads work orders into each quarter to balance the workload for each maintenance resource and to ensure optimum employment of that resource within the work-order priority system.

c. The shop load plan also facilitates analyzing the workforce composition compared to the workload. It identifies personnel or skill shortages or excesses and gives facilities maintenance managers time to respond. Close coordination with the master schedule regarding the status of work in progress is required. Appendix D, Figure D-6, contains a sample shop load plan.

5.7.3.2 Master Schedule. The master schedule is maintained in the shop organization, usually under the direction of the senior shop supervisor. Within the scheduling framework of the shop load plan, it is the week-by-week shop schedule, identifying jobs to individual shops. It covers a shorter time period than the shop load plan, typically 6-to-12 weeks. Work orders are initially placed in the master schedule and noted as awaiting material. When material is available and the job is ready to start, it is firmly scheduled. Close coordination with the shop load plan and shop schedules is required. The master schedule changes as priorities are adjusted, new work is identified, and material status changes. The shop load plan can be used as a model for the master schedule. Appendix D, Figure D-7, contains a sample master schedule.

5.7.3.3 Shop Schedule. Within the framework of the master schedule, the shop schedule is used to schedule the day-by-day work orders and craft personnel within a shop. It is maintained by the shop supervisor and used to assign work and track progress. The shop schedule can be patterned after the master schedule. Appendix D, Figure D-8, includes a sample shop schedule.

5.7.3.4 Schedule Automation. The shop load plan, master schedule, and shop schedule are all based on the same database, differing slightly in the information displayed and the period covered. It is possible to maintain a single scheduling system on a networked CMMS working from a shared database, provided the CMMS has the necessary scheduling features. This gives the added advantage of automatically coordinating the schedules and changes at all levels of management. Some CMMSs may have an integrated scheduling module (See Appendix E, paragraph 8, Work Management, for a sample work scheduling module) that provides functional equivalents to the shop load plan, the master schedule, and the shop schedules that can be used to prepare detailed project schedules for the more complex work projects.

5.7.3.5 Scheduling Considerations

a. The following factors should be considered in scheduling work performance:

1. Preventive Maintenance. PM (including PT&I) provides the baseline workload for the facilities maintenance shops. An effective PM program minimizes the need for TCs and repair. Efficiencies can be obtained by using employees dedicated to PM work because they become familiar with the equipment. PM work orders should be scheduled and grouped by facility or geographical area to minimize travel.

2. One-time Work Orders. Work orders for one-time jobs require the greatest scheduling coordination and management effort. This is due to the unique requirements of each job.

3. Repetitive Work Orders. These are similar to PM jobs in that they are a predictable level of effort and frequently are a continuing or repeating work requirement such as Grounds Care, street sweeping, relamping, and Central Utility Plant Operations Maintenance. Like PM, they are scheduled as part of the baseline shop workload.

4. Trouble Calls. TCs of an emergency nature are assigned to the shop most qualified to address the problem and take precedence over any other work, including work in progress. This TC work proceeds until the situation is corrected or stabilized. To complete the correction of a problem, such as a water-main break, may require the subsequent issue of a repair work order. Most routine TCs can be accomplished by the work center assigned to perform small jobs, as discussed in paragraph 3.4.8, Work Grouping. Equipping key facilities maintenance workers with radios, cell phones, or pagers can enhance their response and productivity.

5. Small Jobs. Small jobs, typically those requiring less than 20 work hours and issued on TC tickets, are normally worked on a first-come, first-served basis, subject to the availability of material. Because they can represent a fairly constant level of effort and normally involve routine methods and materials, it is common practice to have a shop dedicated to this size work.

b. When a TC shop is used, it should be able to complete about 90 percent of TCs and small work orders; the remaining 10 percent are used as fill-in work for other shops. This shop should be sized to be able to complete urgent (nonemergency) work within the day and non-emergency routine work within 5-to-10 workdays of receipt, subject to material availability. The size and type of the TC shop depends on local conditions and historical data such as volume, nature of work, geographic proximity, and availability of transportation and materials. In the interest of efficiency and minimizing travel time, small jobs may be grouped by building or geographic area. The use of dedicated, radio-equipped vehicles stocked with preexpended, commonly used facilities maintenance material and proper tools will improve productivity.

5.7.4 Work Performance. When all material is available and coordination and scheduling are completed, the work order is executed. Work proceeds to completion in accordance with the approved work order. However, the shops should be free to communicate with the P&Es to resolve questions about the work. If field conditions differ substantially from the work order or the effort and material required differ substantially from the work-order estimate, the supervisor should check with the P&E for an amendment or clarification and review the priority and schedule to ensure that completion dates will not be missed. The threshold for a work-order amendment is based on Center management needs; however, a 20-percent or greater increase from the estimate is suggested as a deviation requiring a work-order amendment.

5.7.4.1 Quality Control. This function is a responsibility of the organization executing the work. Shop supervisors usually have the primary responsibility for work quality control based on policies and procedures of the organization responsible for the work.

5.7.4.2 Quality Assurance. Regardless of who performs work, it should be subject to inspections for quality and compliance with work requirements. See paragraph 3.4.11, Quality Assurance, and Chapter 12, Contract Support, for details on quality assurance programs.

5.7.5 Work Acceptance

5.7.5.1 Final Inspection. Final inspections are performed as appropriate depending on the nature and size of the completed work. If the work to be inspected is for a customer, the customer should participate in the final inspection in order to accept the work. If customer expectation goes beyond the work-order scope, the job should be reviewed promptly for resolution.

5.7.5.2 Defective Work. Defective or rejected work occurs for a number of reasons, including poor workmanship, an incorrectly scoped and prepared work order, defective material, or poorly defined customer requirements.

a. When defective work is discovered, it shall be corrected by the performing organization to satisfy the work requirements.

b. Correction of safety-related deficiencies shall likewise be accomplished immediately by the performing organization.

5.7.5.3 Rework Causes and Correction

A decision to rework a job should be based on cost-benefit considerations, including Center operational commitments, cost to rework the job, expected added benefit as a result of rework, and availability of resources. Separate work orders should be established to accumulate rework data. Other situations that would require rework are jobs that do not meet safety regulations and/or other mandatory laws. The evaluation process should address causes of defective work and methods of reducing rework. Remedial actions may include revising internal procedures such as quality control procedures, providing additional employee training and skill development, changing material specifications, adding early material acceptance inspections, revising facilities maintenance standards and requirements, and increasing customer involvement with work order preparation and approval. Each Center should have a policy for handling rework. In cases where rework of contract efforts is being considered, the cognizant procurement office shall be consulted.

In general, the customer should not have to bear the cost of facilities maintenance rework resulting from errors by another party, and the Government should not have to bear the cost of rework that results from a contractor's error or negligence. Inspection clauses shall be included in contracts to require the contractor to perform rework at the contractor's own expense, to reimburse the Government for rework performed by the Government, or to reduce contractor payments for rework not performed. The amount of rework should be considered as an evaluation factor when determining contract award fees.

5.7.5.4 Completion Reporting. When the work has been completed and accepted, a completion report is submitted. This reporting involves recording in the CMMS the work completion, the resources used, and closing the work order. Care must be exercised to identify and record all of the work accomplished, particularly when the initial request is sketchy or incomplete. The labor and material used are recorded for record and accounting purposes. The results are recorded in the facility or equipment history files, and evaluation action is initiated. The information reported should include unanticipated conditions encountered, a concise description of the work accomplished, and additional material used but not listed in the work order. Work order forms (including TC tickets) should include space for the technician to enter completion data. Shop supervisors should review the completion data. All documents and records should be filed and retained in accordance with guidance provided in NPR 1441.1, NASA Records Retention Schedules.

5.7.6 Management Information (Metrics, Analysis, and Reporting). The loop on the maintenance management system is closed by evaluating completed work to compare actual work performance with estimates for quality assurance (whether performed in-house or by contract) and to ensure conformance with work-order instructions, standards, customer satisfaction, and accuracy of completed work for costing and reporting purposes. It appraises the performance of each element of the facilities maintenance management system and initiates corrective action when needed. Thus, evaluation provides for the continuous improvement of workflow through the organization and the CMMS.

5.7.6.1 Determining Information Requirements. Reports, charts, and other displays that do not directly contribute to facilities maintenance management, or other Centers' or NASA Headquarters' needs are a waste of scarce resources. Therefore, information should be collected, processed, or documented to support a clear need. A summary of recommended facilities maintenance indicators and reports is given in paragraph 5.7.6.3, Analysis, Reports, and Records. Centers should specify the information to be displayed and distributed in their reports. Data that is not required to support management functions should not be collected or maintained. Over time, data loses its

value to the manager. For example, a summary of last year's TCs by month and by trade would be more useful to the manager at this point than a voluminous record of all the actual calls. Managers shall develop archiving plans to reduce the volume of outdated data in the active database while retaining those elements of the data that are useful for trending and analysis. The archived data also shall be maintained for possible future use in providing historical data for performance-based contracts.

5.7.6.2 Covered Functions. As discussed in Chapter 6, Facilities Maintenance Management Automation, the Center's CMMS includes day-to-day work records and historical data. This electronic data and information from other electronic systems that may or may not interface with the CMMS can be used to cover the full range of facilities maintenance functions.

5.7.6.3 Analysis, Reports, and Records

a. One major function of a CMMS is to provide maintenance data for automated analysis and reports to support management needs. The analysis should examine both status and trends. Graphical presentation of numerical data and trends will aid managers in understanding the implications of the data. The following is a discussion of several types of analyses and reports that may be important to a facilities maintenance manager.

b. Information provided in the reports is available for analysis with metrics, as discussed in paragraph 3.11, Management Indicators, and Appendix G. This analysis is a portion of the facilities maintenance program shown in Figure 3-2.

c. The following descriptions are intentionally unstructured. Managers should select and tailor them to fit local data and needs.

1. Status Reports. The following reports provide a "snapshot" of where maintenance operations are at a given time:

(a) Inventory. This report could include displays of facilities and maintainable collateral equipment inventory statistics, use, user, age profiles, and similar data. Significant portions of this information can be used in space management and planning.

(b) Status of Funds. This type of report would provide up-to-date status of funds by source, including amounts authorized, reserved, and obligated. It would also include a comparison of planned versus actual expenditure rates.

(c) Status of Work. This report, which should be obtained from CMMS data, could provide the status of all work submitted to the facilities maintenance organization. It would show a short title for the work, work-generation date, who or which organizational element has action, and an estimated completion date, if applicable. Variations of this report could include arranging the information by customer, work classification, status (grouping work items with similar status into one report), or facility. It could take the form of a history of selected work items showing work progress through the facilities maintenance system.

(d) Status of Major Projects. This report would include major undertakings such as CoF projects, major facilities maintenance projects, and projects of special Center interest. The reports should reflect cost estimates, project milestones, and progress against those milestones.

(e) AWP Execution Status. The CMMS should provide a display of annual resource requirements and the status for the major line items within each element that makes up the AWP. This includes PM, PT&I, Grounds Care, PGM, repair, TC, ROI, Service Requests, Central Utilities Plant Operations & Maintenance, CoF, and related factors. It also should display current budget estimates for out-years and the DM .

(f) Status of DM. This report should give the facilities maintenance manager an update on the amount of DM by facility and facility classification (Mission Critical , Mission Support, and Center Support) and total for the Center. It should also include the amount of DM by system, such as roofs; heating, ventilating, and air conditioning (HVAC) systems; structures; roads; and other systems. This will facilitate long-range programming in the Five-Year Maintenance Plan and provide information for the NASA Headquarters metrics.

(g) Contracts. This report could include the status of contracts, contract execution, pending and executed modifications, and delivery orders. This should cover support service, one-time facilities maintenance, and CoF contracts.

(h) Materials. This report could include the status of materials inventory, orders, and jobs awaiting material.

2. Work Performance Reports

(a) Work Input. Reports on work input include statistics on work generation and the characteristics of that work. They may include information on service requests (arranged and tabulated by date of request, customer, special interest area, facility number, and craft) and work orders generated by the inspection program (PM inspections, PT&I, continuous inspections, operator inspections, and specialized inspections), PM program, PGM program, repair program, and TCs.

(b) Work Execution. Reports on work execution include information on shop schedules, planned work, job status,

estimated versus actual job performance, delayed or late jobs, and related performance indicators. They also include progress on the PM, PGM, PT&I, and condition assessment programs.

(c) Utilities. This report would contain information on production, consumption, costs, conservation measures and targets, and related factors such as weather profiles.

(d) Other Reports. This category is a catchall for those reports not directly tied to facilities maintenance but closely related to or supporting facilities maintenance efforts. Examples include personnel status, correspondence tickler and tracking system, and automation system statistics.

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